**Abundance and run timing of adult Pacific salmon in Big Creek,
Becharof National Wildlife Refuge, 2003**

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Abstract.- The King Salmon Fish and Wildlife Field Office has operated a weir on Big Creek, Becharof National Wildlife Refuge, since 2000 to estimate Pacific salmon escapement. Salmon are an important Refuge resource, and accurate escapement estimates are needed to conserve these species. Prior to the weir, the only escapement data available for Big Creek were aerial index counts for Chinook salmon *Oncorhynchus tshawytscha*. Since 2002, the operation of the V-shaped floating resistance board weir has included the use of digital video equipment to monitor fish passage. In 2003, the video monitoring chute was open at all times other than for collecting biological samples, allowing fish to pass freely through the weir. The use of video monitoring equipment in 2003 resulted in a more comprehensive count of non-salmon species passing the weir than in previous years. In 2003, 10,063 Chinook, 33,943 chum *O. keta*, 9,600 coho *O. kisutch*, 873 pink *O. gorbuscha*, and 119 sockeye *O. nerka* salmon passed the Big Creek weir. A large proportion (35%) of the Chinook salmon run in 2003 was age 1.1 fish (jacks).

Introduction

The Alaska National Interest Lands Conservation Act specifically mandates that fish populations and their habitats be conserved in their natural diversity within the Becharof National Wildlife Refuge (Refuge; U.S. Fish and Wildlife Service (USFWS) 1994). The conservation of chum *Oncorhynchus keta*, Chinook *O. tshawytscha*, coho *O. kisutch*, sockeye *O. nerka*, and pink *O. gorbuscha* salmon stocks that are exploited in commercial, sport, and subsistence fisheries requires accurate monitoring of escapement. Big Creek, the largest tributary to the Naknek River, provides important spawning habitat for Chinook, chum, and coho salmon. The majority of adult salmon spawning in Big Creek likely occurs within Refuge boundaries. Therefore, it is necessary to determine current levels of escapement to ensure conservation of these Pacific salmon stocks originating from the Refuge. In addition, information on human use and dependence upon Refuge resources is becoming more important as competition and conflict begins to develop

between user groups for the same finite resources (USFWS 1994). Monitoring salmon escapement in Big Creek will provide managers with stock status data that can be used to manage these fisheries. Management decisions based on this information will benefit commercial, subsistence, and sport users.

Conflicts between Chinook salmon commercial, subsistence, and sport fishermen in the Naknek River drainage have increased in recent years due to an increase in competition for a limited resource. From 1994 to 1998, commercial harvest of Chinook salmon has averaged 4,116 (42%), sport harvest has averaged 3,710 (38%), and subsistence harvest has averaged 2,009 (20%) (Dunaway and Sonnichsen 2001). In an attempt to balance increasing harvest with escapement goals, the Alaska Department of Fish and Game (ADFG) has implemented seasonal commercial and sport fishing closures, as well as harvest and gear restrictions, to protect Chinook salmon in the Naknek River drainage. The biological escapement goal for Chinook salmon in the Naknek drainage is 5,000 spawning adults as indexed by aerial surveys (Dunaway and Sonnichsen 2001). This goal is based on index counts, and therefore represents a minimum estimate of total escapement. Adult Chinook salmon returning to spawn in Big Creek represent a sizeable portion of the entire Naknek River escapement. From 1990 to 2002, Chinook salmon escapement in Big Creek has averaged 35% of the total escapement into the Naknek River drainage, ranging from 895 to 2,531 (Sands et al. 2003). Numbers of Chinook salmon counted past the Big Creek weir from 2000 to 2002 ranged from 649 to 4,791, although numbers were not complete counts in some years (Whitton 2003).

Coho salmon are also targeted by sport fishermen in the Naknek River drainage, with an average sport harvest of 2,982 during 1994-1998; nearly 5,000 fish were harvested in 1996 (Dunaway and Sonnichsen 2001). Currently, the ADFG has not established a biological escapement goal or management objectives, and no monitoring program exists to assess spawning escapement or overall exploitation of coho salmon in the Naknek River drainage (Dunaway and Sonnichsen 2001). Declines seen in some coho salmon runs in the ADFG Southwest Management Area may be due to excessive harvest, but the lack of escapement data prevents managers from verifying this conclusion (Minard et al. 1998). The lack of escapement data has become a major concern, and without this information it is difficult to determine the health of coho salmon stocks and thus determine appropriate escapement and harvest goals. Coho salmon counts past the Big Creek weir from 2000 to 2002 ranged from 806 to 4,523, although counts were not complete in some years (Whitton 2003).

The ADFG does not have biological escapement goals or escapement monitoring for chum or pink salmon in the Naknek River drainage. Harvest in the commercial fishery is monitored, however, and 11,879 chum and 12 pink salmon were harvested in the Naknek River commercial fishery in 2002 (Weiland et al. 2003). Chum salmon passage at the Big Creek weir ranged from 3,240 to 28,812, and pink salmon passage ranged from 15 to 80 during 2000-2002 (Whitton 2003).

In 2000, the King Salmon Fish and Wildlife Field Office (KSFO) initiated a multi year study on Big Creek to:

1. Enumerate escapement of chum, Chinook, coho, sockeye, and pink salmon in Big Creek from 15 June to 15 October;
2. Describe the run timing of chum, Chinook, coho, sockeye, and pink salmon through the weir;
3. Estimate the weekly age and sex composition of spawning chum, Chinook, and coho salmon in Big Creek, such that simultaneous 90% confidence intervals have a maximum width of 0.20;
4. Estimate the mean length of chum, Chinook, and coho salmon by sex and age; and
5. Characterize current public use on Big Creek and Becharof National Wildlife Refuge lands by conducting a general survey of boaters passing the weir.

Whitton (2003) reports results of the project from 2000 to 2002. This report focuses on work accomplished in 2003.

Study Area

Big Creek originates in the mountains south of Brooks Lake in Katmai National Park and flows northwest about 60 km before joining the Naknek River, 6 km east of King Salmon, Alaska (Figure 1). The drainage contains numerous tributaries, small lakes, and ponds and is almost entirely located within Refuge boundaries. Big Creek is a clear water stream that supports five species of Pacific salmon and spawning populations of rainbow trout *O. mykiss*, Dolly Varden *Salvelinus malma*, Arctic grayling *Thymallus arcticus,* and northern pike *Esox lucius*. Round whitefish *Prosopium cylindraceum* and longnose sucker *Catostomus catostomus* are also present in Big Creek. The weir site is 35 km upriver from the confluence of Big Creek and the Naknek River. This section of the stream is characterized by glides and riffles flowing over sand, gravel, and small cobble substrate. Willow *Salix* spp., birch *Betula* spp., and grasses dominate the riparian zone. Maximum discharge often occurs during spring breakup, but periods of high discharge also occur during periods of heavy rainfall between late July and October.
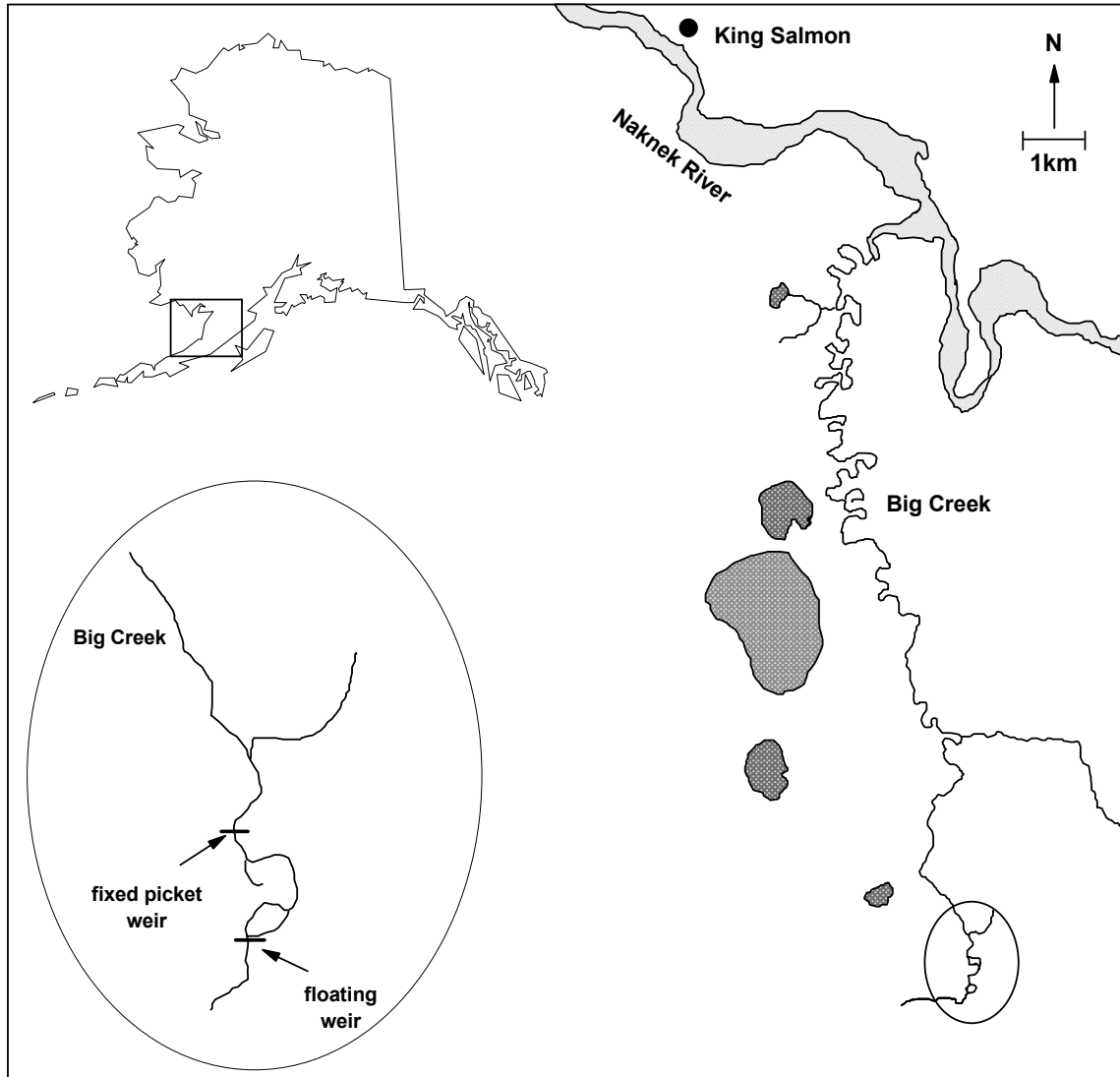
Figure 1. Big Creek study area showing the fixed picket weir used during 2000 - 2001, and floating weir site used since September 2001, Becharof National Wildlife Refuge.

Methods

Escapement Monitoring

KSFO has operated a weir on Big Creek since 2000. In 2002, the fixed-picket weir used in 2000 and 2001 was replaced with a nontraditional resistance-board weir. The new weir was modeled after designs reported by Tobin (1994), with modifications so that it could be constructed and installed in a V-shaped formation that directs upstream migrant fish to a trap box and video passage chute positioned at the apex of the V. Weir panels were constructed from 4.6-m lengths of polyvinyl chloride (PVC) electrical conduit pickets separated by 38-mm lengths of PVC. Aircraft cable (3 mm in diameter) was used to string the pickets and PVC spacers together, and clamps were attached to the ends of the cables to create 1.2-m wide panels. Six stringers were installed on each panel to provide rigidity. To prevent adult salmon from squeezing between pickets, pickets were spaced 32 mm apart. Panels were attached to an 8-mm diameter cable secured to the stream bottom with duckbill anchors. Adjustable resistance boards, constructed of plywood (6 mm thick) and waterproof Styrofoam, were attached to the downstream end of panels to provide flotation. Four weir panels were modified to allow boats to pass the weir. The V-shaped resistance-board weir was operated from 26 June to 2 October 2003 when it was submerged by high water. During the period of operation, the weir was inspected, cleaned, and maintained daily to insure integrity.

To facilitate fish passage and reduce the number of fish handled at the weir, a video monitoring system was incorporated into the weir (Hetrick et al. *In preparation*). The video monitoring system consisted of a Sony 410,000 pixel 1/3" "Super HAD" CCD imager attached to a fixed-focus, auto iris 3.6 mm wide angle lens mounted in a sealed, waterproof aluminum housing, rated at 480 TV lines of resolution. The camera was mounted in a sealed aluminum video box filled with filtered water treated with an algaecide. Images were collected through a clear safety-glass window fixed to the front of the video box. The distance between the lens and the glass window provided separation between upstream migrant fish and the lens, as needed to obtain full frame images of large fish like Chinook salmon. This sealed video box design was developed to allow underwater video equipment to operate in the fall when frequent rains often create turbid water conditions. In turbid water, image quality is maintained as the majority of the distance between fish and the lens is within the filtered water contained in the video box. The video box was attached to a fish passage chute that was lit from above and the side by four, 4-foot long, 12-volt fluorescent light fixtures. Lights were positioned at greater than 45° in relation to the camera to minimize backscatter and disperse lighting to eliminate "hot spots". The camera was connected to a Sanyo DSR-3000 digital video recorder using a shielded coaxial cable. The digital video recorder processed the video stream using motion detection hardware and software to eliminate blank footage, and digitally recorded footage containing fish for later counting and identification.

Vertical sliding doors were installed in both the trap box and fish passage chute. When fish were not being collected for biological sampling, the trap box was closed and fish were passed through the video monitoring chute. This allowed fish to pass freely through the weir unless the video chute was closed to capture fish for biological sampling.

Stream discharge (flow; m^3/s) was monitored at a site near the Big Creek weir. The site was selected in an area with uniform water depth and velocity to minimize sampling error. Discharge was measured using the methods of Gordon et al. (1992), and water velocity was measured with a Marsh-McBirney model 201 flow meter. Stage height (ft/tenths) was measured twice daily from a staff gauge. A stage-discharge relationship was not established at the Big Creek weir in 2003, as only four discharge measurements were taken.

Water temperature was monitored in 2003 with a Hobo® Temp data logger that recorded temperatures every two hours. The data logger was placed in a secure, well-mixed, shaded site near the weir. Water temperatures were summarized as daily mean, maximum, and minimum.

Age, Sex, and Length Data

Data for Chinook, chum, and coho salmon age, sex, and length (ASL) were collected using a temporally stratified sampling design (Cochran 1977), with statistical weeks defining strata. All species were sampled weekly for ASL information, and the samples were collected uniformly throughout the week (Sunday through Saturday). To avoid potential bias caused by the selection or capture of individual fish, all target species within the trap were included in the sample even if the sample size goal for a species was exceeded. Although weir passage was stratified into statistical weeks a priori, strata for the analysis of Pacific salmon biological data at the Big Creek weir were modified following the field season to represent actual weir passage (Table 1).

Maximum weekly sample size goals were established such that simultaneous 90% interval estimates of age composition for each week have maximum widths of 0.20 (Bromaghin 1993; Table 2). Sample sizes obtained using these methods were increased to account for the expected number of unreadable scales. The derivation of maximum sample size goals was based on a multinomial sampling model (sampling with replacement or small samples relative to a large population). For some salmon species, the sample size goal was expected to be a substantial fraction of the passage in some weeks; therefore, during weeks of low passage when the maximum sample size goal could not be practically obtained, about 20% of the weekly escapement was sampled. This was sufficient to describe the age composition and reduce the number of fish handled at the weir. For sample size determination, age categories were defined as the total age (fresh water and ocean age combined) for all species.

Samples for ASL data were collected using a dip net to remove fish from the trap box at least once daily or more often as the number of fish moving through the weir increased.

Table 1. Strata (time periods) used for analysis of Big Creek biological data, 2003.

Stratum	Chinook salmon	Chum salmon	Coho salmon
1	26 June - 4 July	29 June - 5 July	26 July - 23 Aug.
2	5 - 12 July	6 - 12 July	24 - 30 Aug.
3	13 - 19 July	13 - 19 July	31 Aug. - 6 Sept.
4	20 - 26 July	20 - 26 July	7 -13 Sept.
5	27 July - 2 Aug.	27 July - 2 Aug.	14 - 20 Sept.
6	3 Aug. - 12 Sept.	3 - 9 Aug.	21 - 27 Sept.
7	--	10 - 16 Aug.	28 Sept. - 2 Oct.
8	--	17 - 23 Aug.	--
9	--	24 Aug - 30 Sept.	--

Table 2. Maximum weekly sample size goals based on the sampling model of Bromaghin (1993) for collecting age, sex, and length data at the Big Creek weir, 2003.

Species	Number of Age Categories	Sample Size	Percent Unreadable	Adjusted Sample Size
Chum salmon	4	121	10	135
Chinook salmon	4	121	10	135
Coho salmon	3	109	10	122

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Adult salmon were measured to the nearest mm (mid-eye-to-fork length), examined for gill net marks, and the sex of the fish was determined when possible from secondary characteristics. Three scales from each Chinook and coho salmon, and one scale from each chum salmon were removed from the preferred area on the left side of the fish (Jearld 1983), cleaned, and mounted on gummed scale cards. Scales were pressed and aged following the field season by KSFO personnel. Standards and guidelines of Mosher (1968) were used in aging scales. Salmon ages are reported according to the European method described by Jearld (1983) and Mosher (1968), where the number of winters the fish spent in fresh water and in the ocean is separated by a decimal. Fish with scales that could not be aged, or where sex could not be determined from secondary characteristics, were not included in the ASL analysis. A chi-square test of independence (Sokal and Rohlf 1981) was used to determine if age and sex compositions for adult salmon were independent of sampling strata in 2003. Non-target fishes captured in the trap box were identified to species, enumerated, measured to the nearest mm (fork length), and released above the weir. Fish were not allowed to hold downstream of the weir. If this occurred, the trap box was closed and the passage chute was opened to facilitate upstream passage.

Characteristics of Chinook, chum, and coho salmon passing through the weir were estimated using standard stratified random sampling estimators (Cochran 1977). Within a given stratum m, the proportion of species i passing the weir that are of sex j and age k (p_{ijkm}) was estimated as

$$\hat{p}_{ijkm} = \frac{n_{ijkm}}{n_{i++m}},$$

where n_{ijkm} denotes the number of fish of species i, sex j, and age k sampled during stratum m and a subscript of "+" represents summation over all possible values of the corresponding variable, e.g., n_{i++m} denotes the total number of fish of species i sampled in stratum m. The variance of $\hat{p}_{ijkm}$ was estimated as

$$\hat{v}(\hat{p}_{ijkm}) = \left(1 - \frac{n_{i++m}}{N_{i++m}}\right)\frac{\hat{p}_{ijkm}\left(1 - \hat{p}_{ijkm}\right)}{n_{i++m} - 1},$$

where N_{i++m} denotes the total number of species i fish passing the weir in stratum m. The estimated number of fish of species i, sex j, age k passing the weir in stratum m ($\hat{N}_{ijkm}$) was

$$\hat{N}_{ijkm} = N_{i++m}\hat{p}_{ijkm},$$

with estimated variance

$$\hat{v}(\hat{N}_{ijkm}) = N_{i++m}^2\hat{v}(\hat{p}_{ijkm}).$$

Estimates of proportions for the entire period of weir operation were computed as weighted sums of the stratum estimates, i.e.,

$$\hat{p}_{ijk} = \sum_m \left(\frac{N_{i++m}}{N_{i+++}} \right) \hat{p}_{ijkm} \, ,$$

and

$$\hat{v}\left(\hat{p}_{ijk}\right) = \sum_m \left(\frac{N_{i++m}}{N_{i+++}} \right)^2 \hat{v}\left(\hat{p}_{ijkm}\right).$$

The total number of fish in a species, sex, and age category passing the weir during the entire period of operation was estimated as

$$\hat{N}_{ijk} = \sum_m \hat{N}_{ijkm} \, ,$$

with estimated variance

$$\hat{v}\left(\hat{N}_{ijk}\right) = \sum_m \hat{v}\left(\hat{N}_{ijkm}\right).$$

If the length of fish of species i, sex j, and age k sampled in stratum m is denoted x_{ijkm}, the sample mean length of fish of species i, sex j, and age k within stratum m was calculated as

$$\bar{x}_{ijkm} = \frac{\sum x_{ijkm}}{n_{ijkm}} \, ,$$

with corresponding sample variance s^2_{ijkm}

$$s^2_{ijkm} = \left(1 - \frac{n_{ijkm}}{\hat{N}_{ijkm}} \right) \frac{\sum \left(x_{ijkm} - \bar{x}_{ijkm} \right)^2}{n_{ijkm} - 1} \, .$$

The mean length of all fish of species i, sex j, and age k ($\hat{\bar{x}}_{ijk}$) was estimated as a weighted sum of the stratum means, i.e.,

$$\hat{\bar{x}}_{ijk} = \sum_m \left(\frac{\hat{N}_{ijkm}}{\hat{N}_{ijk}} \right) \bar{x}_{ijkm} \, .$$

An approximate estimator of the variance of $\hat{\bar{x}}_{ijk}$ was obtained using the delta method (Seber 1982),

$$\hat{v}\left(\hat{\bar{x}}_{ijk}\right) = \sum_m \left\{ \hat{v}\left(\hat{N}_{ijkm}\right) \left[\frac{x_{ijkm}}{\sum_x \hat{N}_{ijkx}} - \sum_y \frac{\hat{N}_{ijky}}{\left(\sum_x \hat{N}_{ijkx}\right)^2} x_{ijky} \right]^2 + \left(\frac{\hat{N}_{ijkm}}{\sum_x \hat{N}_{ijkx}}\right)^2 s^2_{ijkm} \right\}.$$

Public Use Survey

During 2003, boats traveling downstream at the weir were interviewed opportunistically. The following information was obtained for each interview: (1) primary purpose for visit (hunting, fishing, other); (2) secondary purpose (hunting, fishing, other); (3) reason (subsistence, sport, or other); (4) residence (city, state, or country of residency); (5) guiding status (guided or unguided); (6) target species and the number kept; (7) group size; and (8) time spent on the Refuge (hours or days). Unless boat passage occurred when the crew was present at the weir, boaters were not likely to be interviewed as the weir design allows boats to motor over the weir without stopping.

Results

Escapement Monitoring

From 26 June to 2 October 2003, 33,943 chum, 10,063 Chinook, 9,600 coho, 873 pink, and 119 sockeye salmon were counted past the Big Creek weir (Figures 2 and 3; Appendix A). Chinook salmon were observed at the weir from 26 June to 8 September, with a peak of 1,934 fish passing the weir on 9 July. Chum salmon passed the weir from 30 June to 30 September, with a peak of 2,743 on 5 August. Coho salmon were counted at the weir from 26 July to 1 October, with a peak of 2,406 on 26 September. Estimates for coho salmon are incomplete, as the weir was removed due to high water before the run was over. Neither pink nor sockeye salmon had defined peak migrations past the Big Creek weir in 2003. Dolly Varden ($n = 4,901$), rainbow trout ($n = 549$), round whitefish ($n = 210$), Arctic grayling ($n = 83$), and northern pike ($n = 52$) were observed passing through the weir in 2003 (Figures 3 and 4; Appendix B). Dolly Varden had two migration peaks in 2003, one in mid July that coincided with the Chinook salmon peak migration, and one in early August that coincided with the chum salmon peak migration (Figures 2 and 3). Rainbow trout and round whitefish migrations appeared to peak in early October (Figure 4).
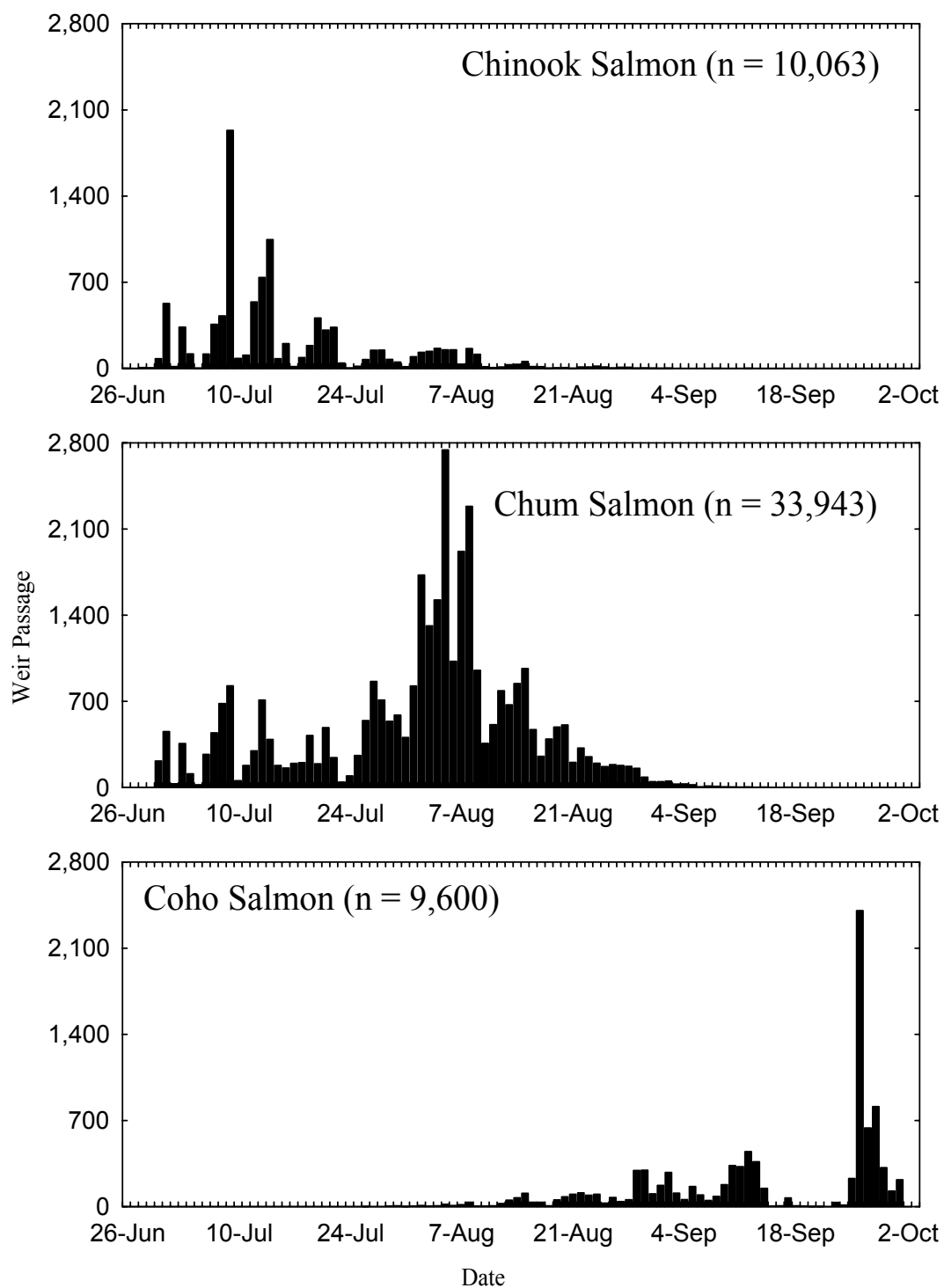
Figure 2. Daily passage of Chinook, chum, and coho salmon at the Big Creek weir, 2003.

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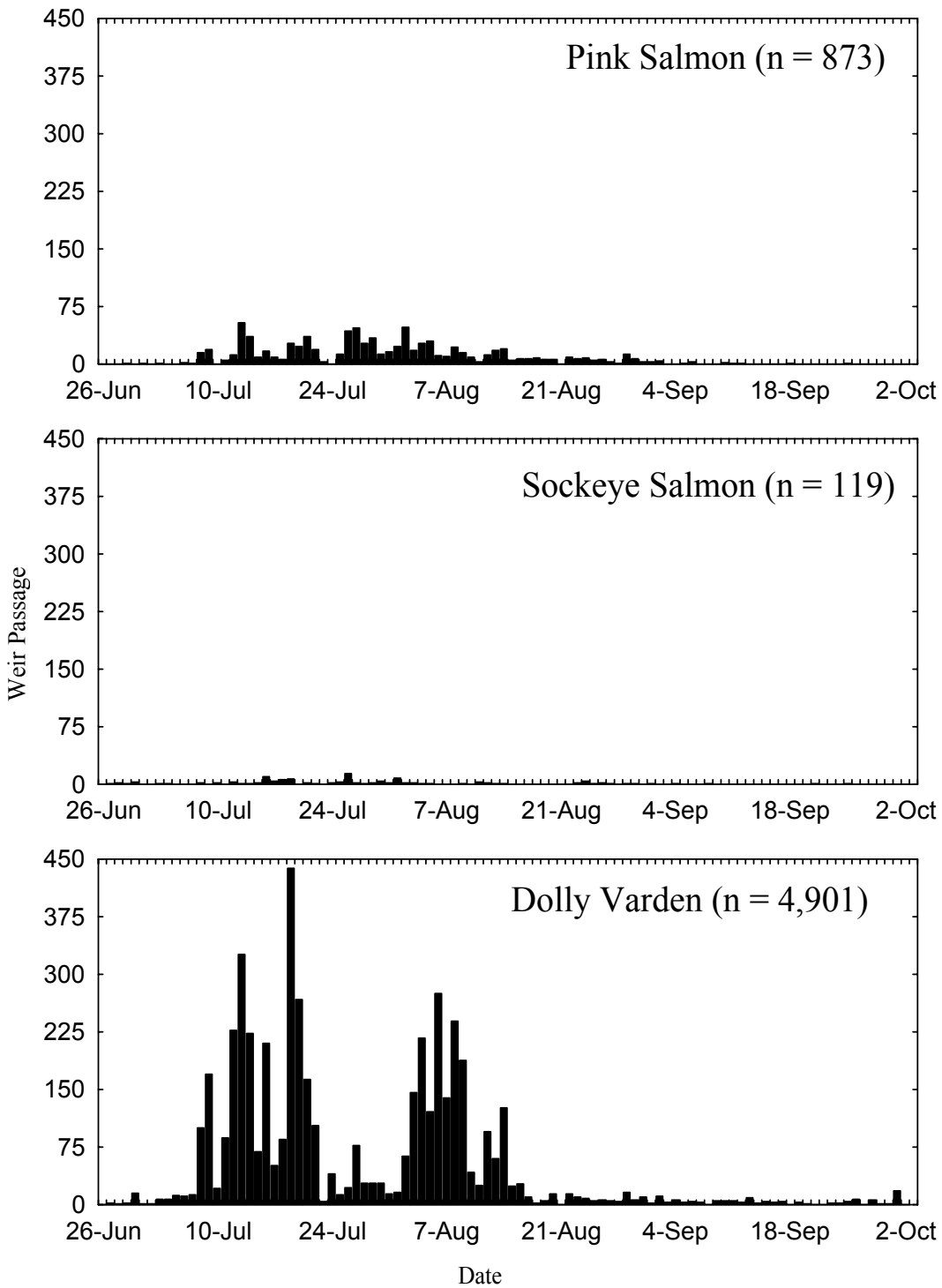
Figure 3. Daily passage of pink salmon, sockeye salmon, and Dolly Varden at the Big Creek weir, 2003.
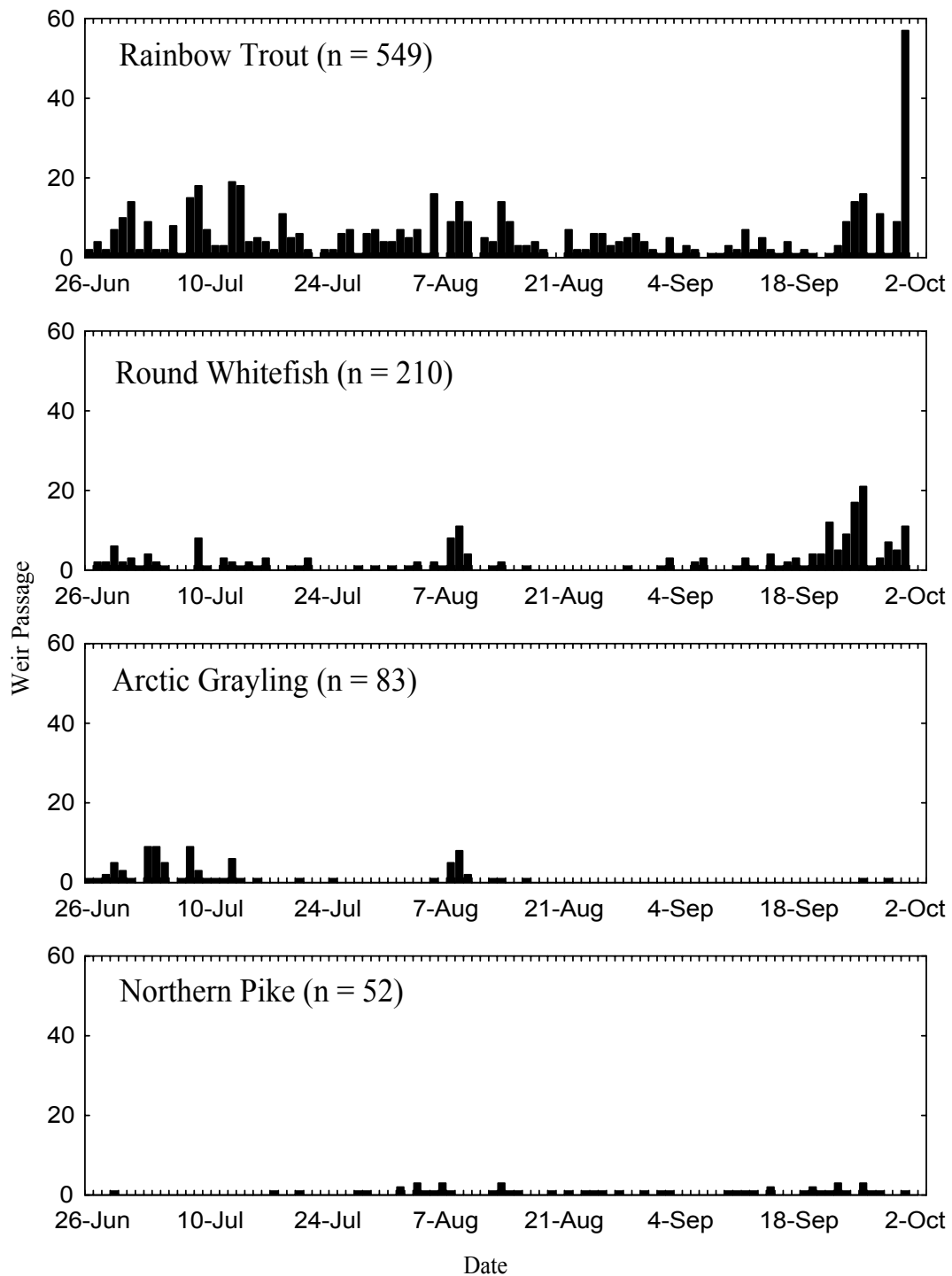
Figure 4. Daily passage of rainbow trout, round whitefish, Arctic grayling, and northern pike at the Big Creek weir, 2003.

Discharge measured near the Big Creek weir ranged from 5.7 m^3/s (stage height = 0.85 ft/tenths) on 10 August to 16.1 m^3/s (stage height = 1.60 ft-tenths) on 27 August. Stage heights ranged from 0.85 ft-tenths on 10 August to 2.30 ft-tenths on 21 August (Figure 5). Two peaks in stage height occurred in 2003, one on 21 August and one on 2 October. A stage-discharge relationship was not established at the Big Creek weir in 2003, as only four discharge measurements were taken.

Water temperatures at the Big Creek weir peaked in early August 2003, with a maximum recorded temperature of 21.7°C on 8 August (Figure 6). Temperatures gradually increased during the summer until the peak, and then decreased until the thermograph was removed on 20 September (Figure 6).

Age, Sex, and Length Data

Six hundred ninety-nine Chinook salmon were sampled for ASL data from 28 June to 27 August 2003. One hundred fourteen scale samples (16%) were unreadable or regenerated, and the sex could not be determined from secondary sexual characteristics for one fish. Five age classes were identified from Chinook salmon scale samples in 2003. Over all strata, age 1.1 fish (jacks) comprised the majority of the run (35%, Table 3). Ages 1.2 (25%) and 1.3 (28%) Chinook salmon were also abundant, and only one age 1.5 Chinook salmon was sampled at the weir in 2003. Age composition varied by sample period in 2003 ($X^2 = 168.25$, $p < 0.001$). Over all strata in 2003, 27% of the Chinook salmon sampled at the weir were females (Table 4). This skewed sex ratio was influenced by the large number of jacks, as all but one age 1.1 fish sampled ($n = 204$) was male. During the two strata (4 and 5) with limited jack passage, the sex ratio was close to 50:50 (Table 4). Sex composition varied by sample period ($X^2 = 54.43$, $p < 0.001$), and ranged from 11% females in stratum 1 to 46% females in stratum 5. Lengths of Chinook salmon sampled in 2003 ranged from 469 to 1,000 mm for females, and from 310 to 1,030 mm for males (Table 5, Figure 7). In general, the more winters a fish spent in the ocean, the larger its size (Figure 8). In 2003, the overall number of Chinook salmon sampled at the Big Creek weir with net marks was low at 6% ($n = 43$). However, over 10% of age 1.3 and 1.4 Chinook salmon were net marked, and during some weeks, the proportion of net-marked Chinook salmon was over 15% (Figure 9).

Twelve hundred sixty-three chum salmon were sampled for ASL data at the Big Creek weir from 30 June to 23 September 2003. One hundred and two scale samples (8%) were unreadable or regenerated, and the sex could not be determined for two fish. Five age classes of chum salmon were identified from scale samples. Age 0.3 fish made up the majority of the run in each stratum and over all strata (91%, Table 6). Only one age 0.1 chum salmon was sampled at the Big Creek weir. Age composition varied by sample period in 2003 ($X^2 = 148.33$, $p < 0.001$). The sex ratio for chum salmon also varied over sample periods in 2003 ($X^2 = 22.05$, $p = 0.005$), and ranged from 45% females in strata 3, 4, and 5 to 63% females in stratum 6 (Table 7). Over all strata in 2003, 54% of the chum salmon sampled at the weir were females. Lengths of chum salmon sampled in 2003 ranged from 372 to 695 mm for females, and from 459 to 690 mm for males (Table 8, Figure 7). The range of lengths for age 0.3 chum salmon covered the observed ranges for

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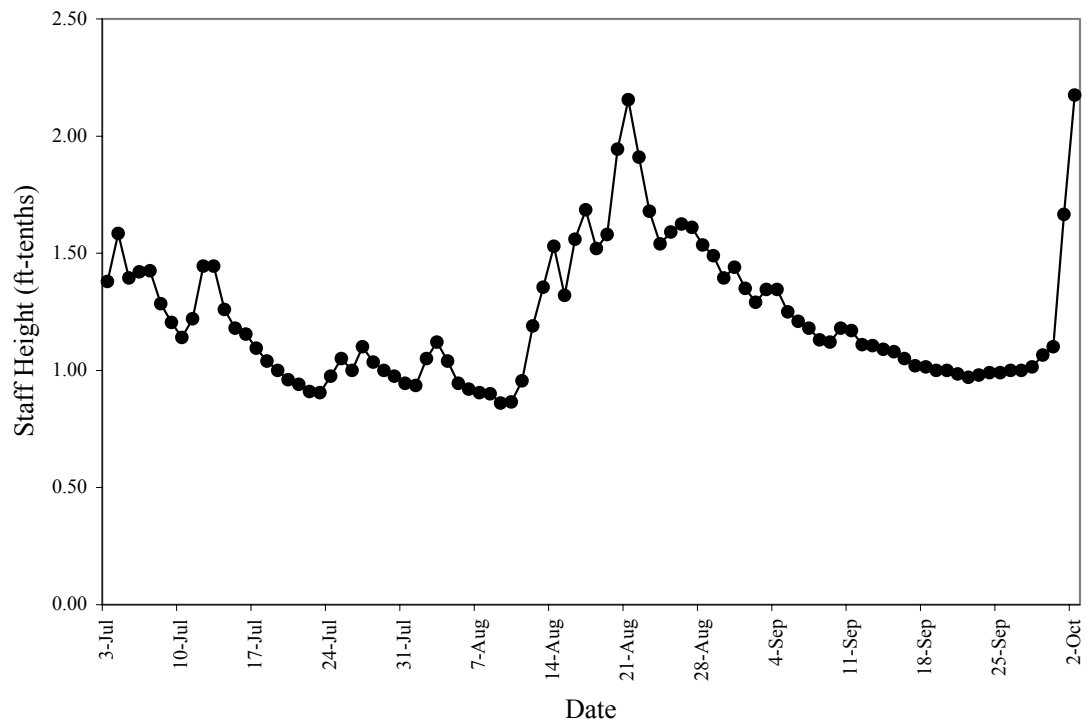
Figure 5. Mean daily stage height (ft/tenths) measured at the Big Creek weir, 2003.
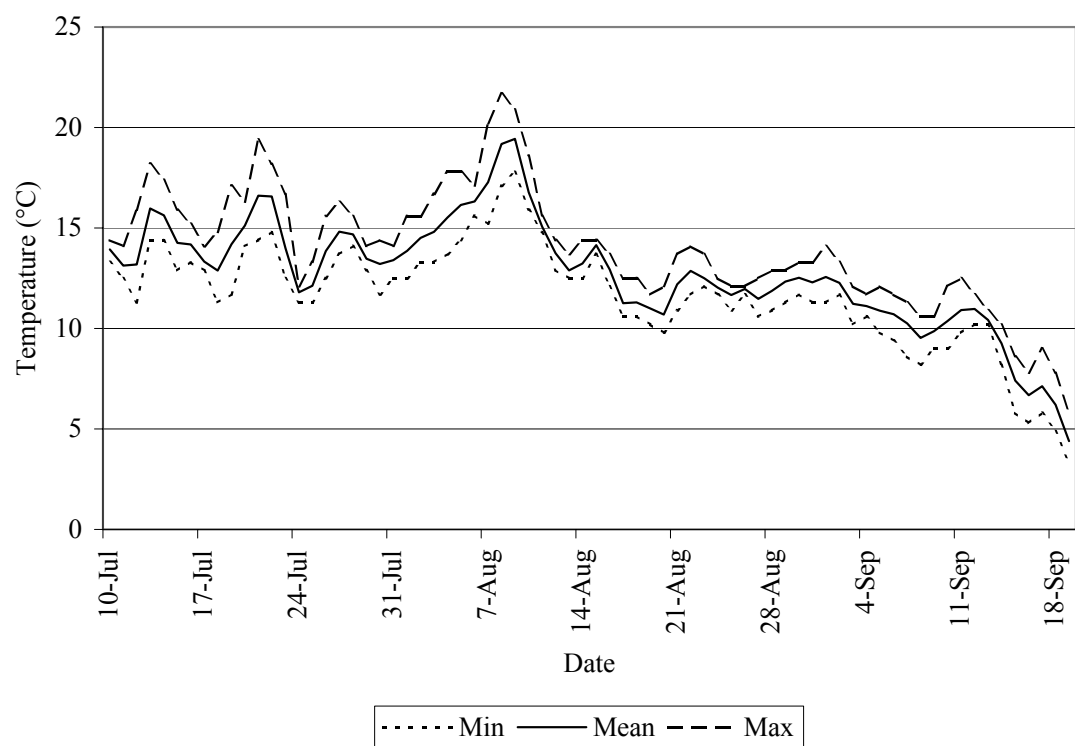
Figure 6. Daily minimum, mean, and maximum water temperatures near the Big Creek weir, 2003.

Table 3. Estimated age composition and standard errors (SE) of Chinook salmon by stratum in Big Creek, 2003.

| Stratum | Number Sampled | | | | | Proportion of Escapement | | | | | | | |
	n^a	1.1	1.2	1.3	1.4	1.1	SE	1.2	SE	1.3	SE	1.4	SE
1	122	77	32	10	3	0.63	0.04	0.26	0.04	0.08	0.02	0.02	0.01
2	122	58	38	22	4	0.48	0.04	0.31	0.04	0.18	0.03	0.03	0.02
3	127	32	34	40	21	0.25	0.04	0.27	0.04	0.31	0.04	0.17	0.03
4	75	4	12	43	16	0.05	0.03	0.16	0.04	0.57	0.06	0.21	0.05
5	68	6	11	31	19	0.09	0.03	0.16	0.04	0.46	0.06	0.28	0.05
6	70	27	14	23	6	0.39	0.06	0.20	0.05	0.33	0.05	0.09	0.03
Total:	584	204	141	169	69	0.35	0.02	0.25	0.02	0.28	0.02	0.11	0.01

[a] Total number sampled includes age 1.5 ($n = 1$) that is not reported in table as it was less than one percent of the sample.

Table 4. Estimated sex composition and standard errors (SE) of Chinook salmon by stratum in Big Creek, 2003.

Stratum	Number Sampled			Proportion of Escapement		
	n	Female	Male	Female	Male	SE
1	122	13	109	0.11	0.89	0.03
2	122	18	104	0.15	0.85	0.03
3	127	45	82	0.35	0.65	0.04
4	75	34	41	0.45	0.55	0.06
5	68	31	37	0.46	0.54	0.06
6	70	22	48	0.31	0.69	0.05
Total:	584	163	421	0.27	0.73	0.02

Table 5. Mean, standard error (SE), range, and sample size of mid-eye-to-fork lengths (mm) by age class taken from Chinook salmon at the Big Creek weir, 2003.

	Age Class				
	1.1	1.2	1.3	1.4	1.5
Females					
Mean Length	607	631	802	876	961
SE	--	45.9	37.1	27.2	--
Range	--	469 - 1,000	562 - 968	610 - 985	--
Sample Size	1	25	79	57	1
Males					
Mean Length	406	577	784	902	--
SE	20.7	60.8	46.7	30.6	--
Range	310 - 646	353 - 898	511 - 982	748 - 1,030	--
Sample Size	203	116	90	12	0
All Fish					
Mean Length	407	586	793	881	961
SE	20.9	56.1	41.3	26.3	--
Range	310 - 646	353 - 1,000	511 - 982	610 - 1,030	--
Sample Size	204	141	169	69	1
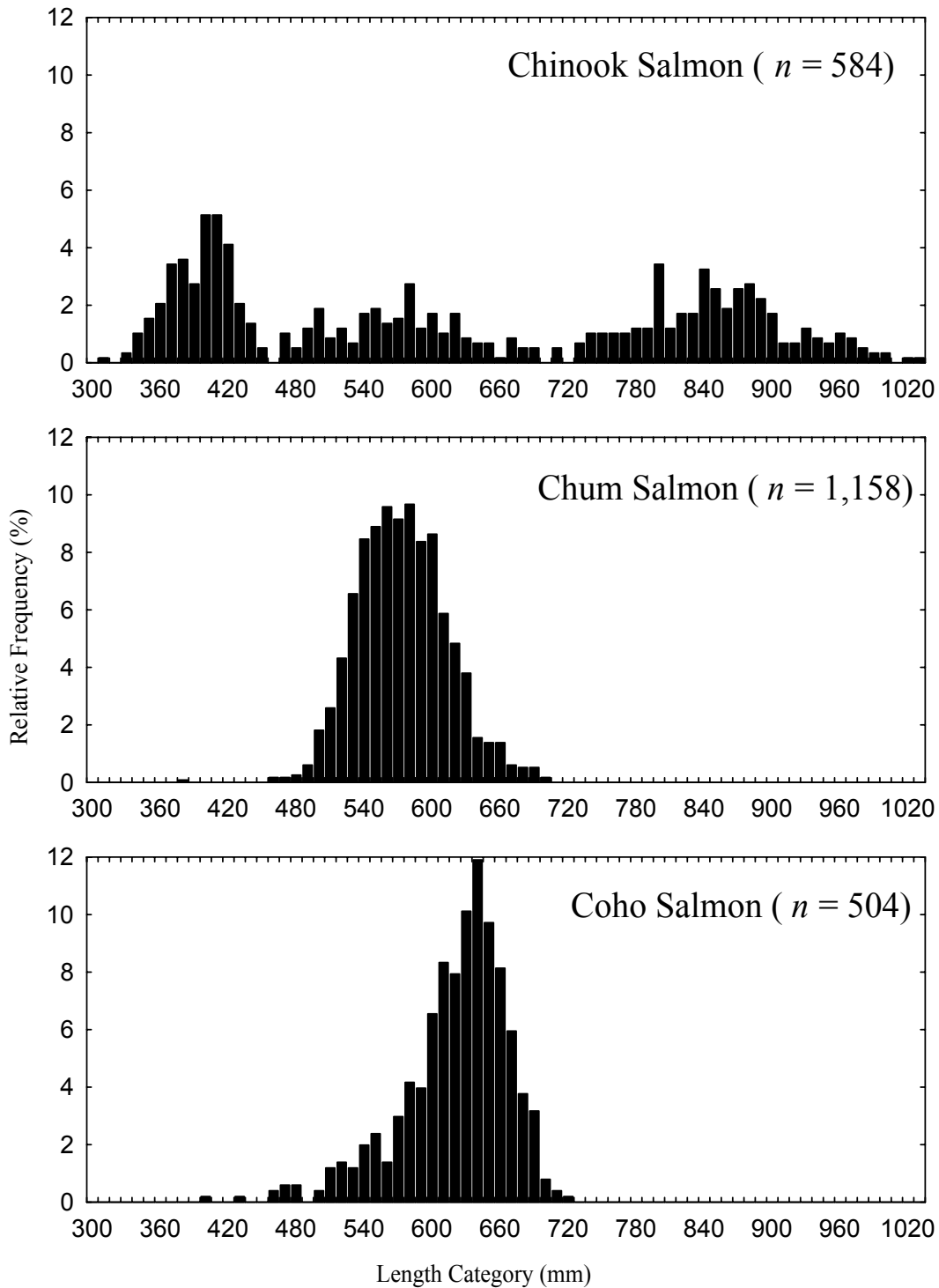
Figure 7. Length-frequency distributions of Chinook, chum, and coho salmon sampled at the Big Creek weir, 2003.
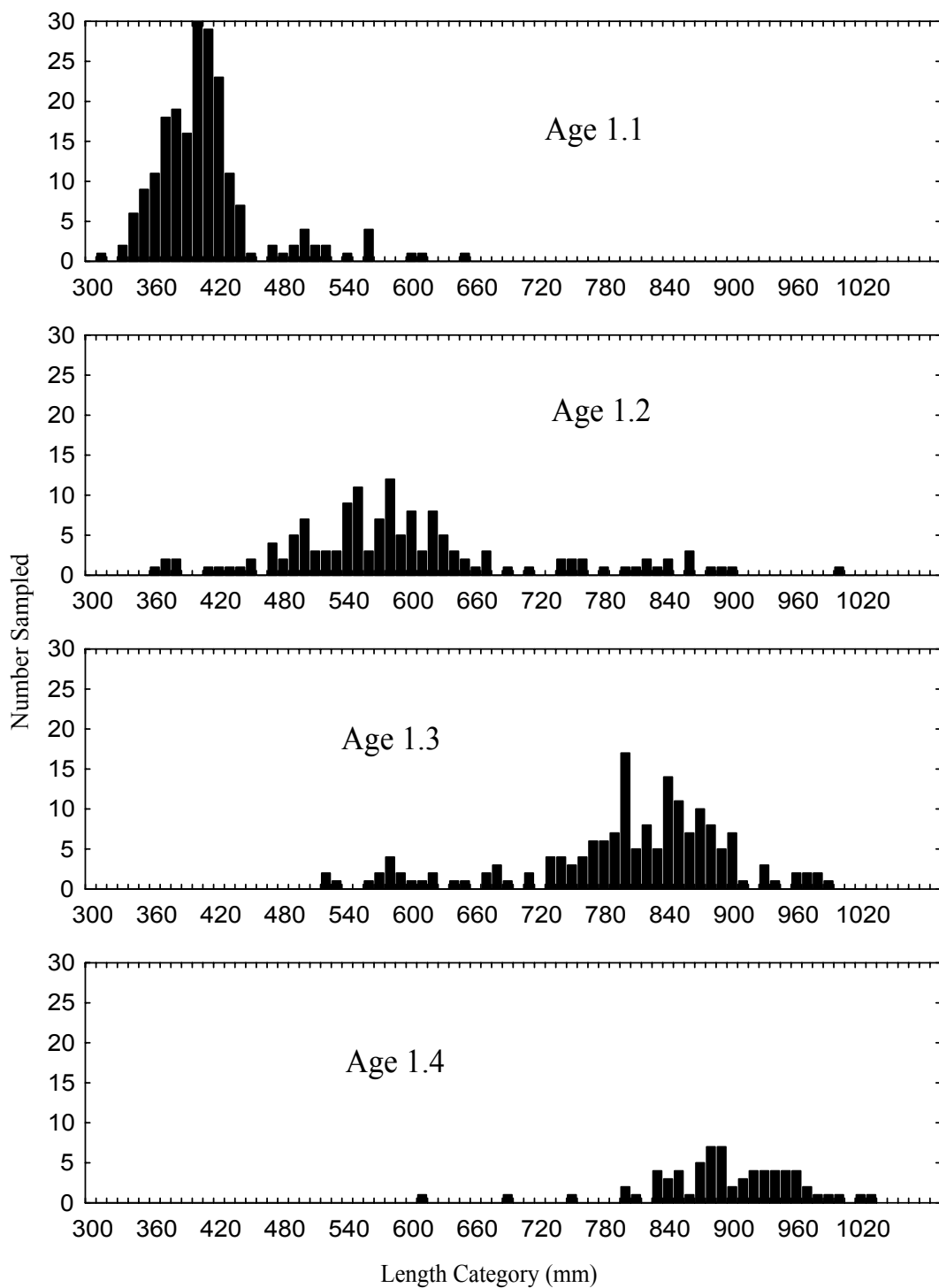
Figure 8. Length-frequency distribution by age for Chinook salmon sampled at the Big Creek weir, 2003.

Figure 9. Percent of Chinook salmon with net marks by age (top) and stratum (bottom) sampled at the Big Creek weir, 2003.

Table 6. Estimated age composition and standard errors (SE) of chum salmon by stratum in Big Creek, 2003.

	Number Sampled					Proportion of Escapement							
Stratum	n^a	0.2	0.3	0.4	0.5	0.2	SE	0.3	SE	0.4	SE	0.5	SE
1	123	1	83	32	7	0.01	0.008	0.67	0.040	0.26	0.038	0.06	0.020
2	124	3	94	22	5	0.02	0.014	0.76	0.038	0.18	0.034	0.04	0.017
3	121	1	93	23	4	0.01	0.008	0.77	0.037	0.19	0.035	0.03	0.016
4	123	3	106	13	1	0.02	0.013	0.86	0.030	0.11	0.027	0.01	0.008
5	121	3	111	7	0	0.02	0.014	0.92	0.025	0.06	0.021	0.00	--
6	123	2	120	1	0	0.02	0.011	0.98	0.014	0.01	0.008	0.00	--
7	128	7	118	2	1	0.05	0.020	0.92	0.023	0.02	0.011	0.01	0.008
8	123	6	115	2	0	0.05	0.019	0.93	0.022	0.02	0.011	0.00	--
9	173	6	162	3	1	0.03	0.013	0.94	0.017	0.02	0.009	0.01	0.005
Total:	1,159	32	1,002	105	19	0.03	0.006	0.91	0.009	0.06	0.006	0.01	0.002

[a] Total number sampled includes age 0.1 ($n = 1$) that is not reported in table as it was less than one percent of the sample.

Table 7. Estimated sex composition and standard errors (SE) of chum salmon by stratum in Big Creek, 2003.

Stratum	Number Sampled			Proportion of Escapement		
	n	Female	Male	Female	Male	SE
1	123	65	58	0.53	0.47	0.04
2	124	58	66	0.47	0.53	0.04
3	121	55	66	0.45	0.55	0.04
4	123	55	68	0.45	0.55	0.04
5	121	54	67	0.45	0.55	0.04
6	123	77	46	0.63	0.37	0.04
7	128	67	61	0.52	0.48	0.04
8	123	73	50	0.59	0.41	0.04
9	173	105	68	0.61	0.39	0.03
Total:	1,159	609	550	0.54	0.46	0.02

Table 8. Mean, standard error (SE), range, and sample size of mid-eye-to-fork lengths (mm) by age class taken from chum salmon at the Big Creek weir, 2003.

	Age Class				
	0.1	0.2	0.3	0.4	0.5
Females					
Mean Length	--	554	554	565	613
SE	--	10.0	13.6	11.7	23.5
Range	--	492 - 596	372 - 695	488 - 686	562 - 648
Sample Size	0	18	540	42	9
Males					
Mean Length	515	546	579	614	607
SE	--	14.7	13.7	16.4	16.7
Range	--	494 - 635	459 - 690	534 - 692	531 - 662
Sample Size	1	14	462	63	10
All Fish					
Mean Length	515	550	565	594	610
SE	--	12.1	14.3	15.7	15.0
Range	--	492 - 635	372 - 695	488 - 692	531 - 662
Sample Size	1	32	1,002	105	19

all other age classes in 2003. The overall number of chum salmon sampled at the Big Creek weir with net marks was low at 5% ($n = 68$). However, over 10% of age 0.3 and 0.4 chum salmon were net marked, and during some weeks, the proportion of net-marked chum salmon was over 15% (Figure 10).

Six hundred eighteen coho salmon were sampled for ASL data at the Big Creek weir from 29 July to 1 October 2003. One hundred twelve scale samples (18%) were unreadable, and the sex could not be determined for two fish. Five age classes of coho salmon were identified from scale samples in 2003. Age 2.1 fish made up the majority of the run in each stratum and over all strata (74%, Table 9). One age 1.2 and four age 2.2 coho salmon were sampled at the Big Creek weir. Age composition varied by sample period in 2003 ($X^2 = 38.64$, $p < 0.001$). The sex ratio for coho salmon also varied over sample periods in 2003 ($X^2 = 15.73$, $p = 0.015$), and ranged from 34% females in stratum 4 to 60% females in stratum 7 (Table 10). Over all strata in 2003, 46% of the coho salmon sampled at the weir were females. Lengths of coho salmon sampled in 2003 ranged from 496 to 714 mm for females, and from 393 to 709 mm for males (Table 11, Figure 7). The range of lengths for age 2.1 coho salmon covered the observed ranges for all other age classes in 2003.

Pink salmon ($n = 65$) sampled at the Big Creek weir ranged in length from 347 to 530 mm, Dolly Varden ($n = 183$) ranged in length from 317 to 556 mm, rainbow trout ($n = 91$) ranged in length from 345 to 675 mm, and round whitefish ($n = 53$) ranged in length from 290 to 480 mm (Figure 11). Sockeye salmon lengths sampled at the weir ($n = 26$) ranged from 294 to 617 mm, northern pike ($n = 17$) lengths ranged from 405 to 755 mm, and Arctic grayling ($n = 28$) lengths ranged from 280 to 433 mm in 2003.

Public Use Survey

Five groups using the Refuge were surveyed at the Big Creek weir in 2003. Four groups were hunting, two groups for moose *Alces alces*, one group for moose and brown bear *Ursus arctos*, and one group for small game. One group was on the Refuge fishing for rainbow trout. Only one of the five groups was a guided party. Two groups were using the Refuge for subsistence purposes, and three groups were sport hunting/fishing. Three parties were from the King Salmon/Naknek area, and two parties did not provide residence information. The number of groups interviewed is not representative of actual Refuge use during the summer and fall of 2003, as numerous boats passed the weir without stopping and were not interviewed.

Discussion

Numbers of fish of all species observed at the Big Creek weir in 2003 were greater than in any previous year from 2000 to 2002 (Table 12). Although some counts may represent larger escapements of certain species than in previous years (e.g., Chinook salmon and chum salmon), much of the observed increase in numbers for non-salmon species is due
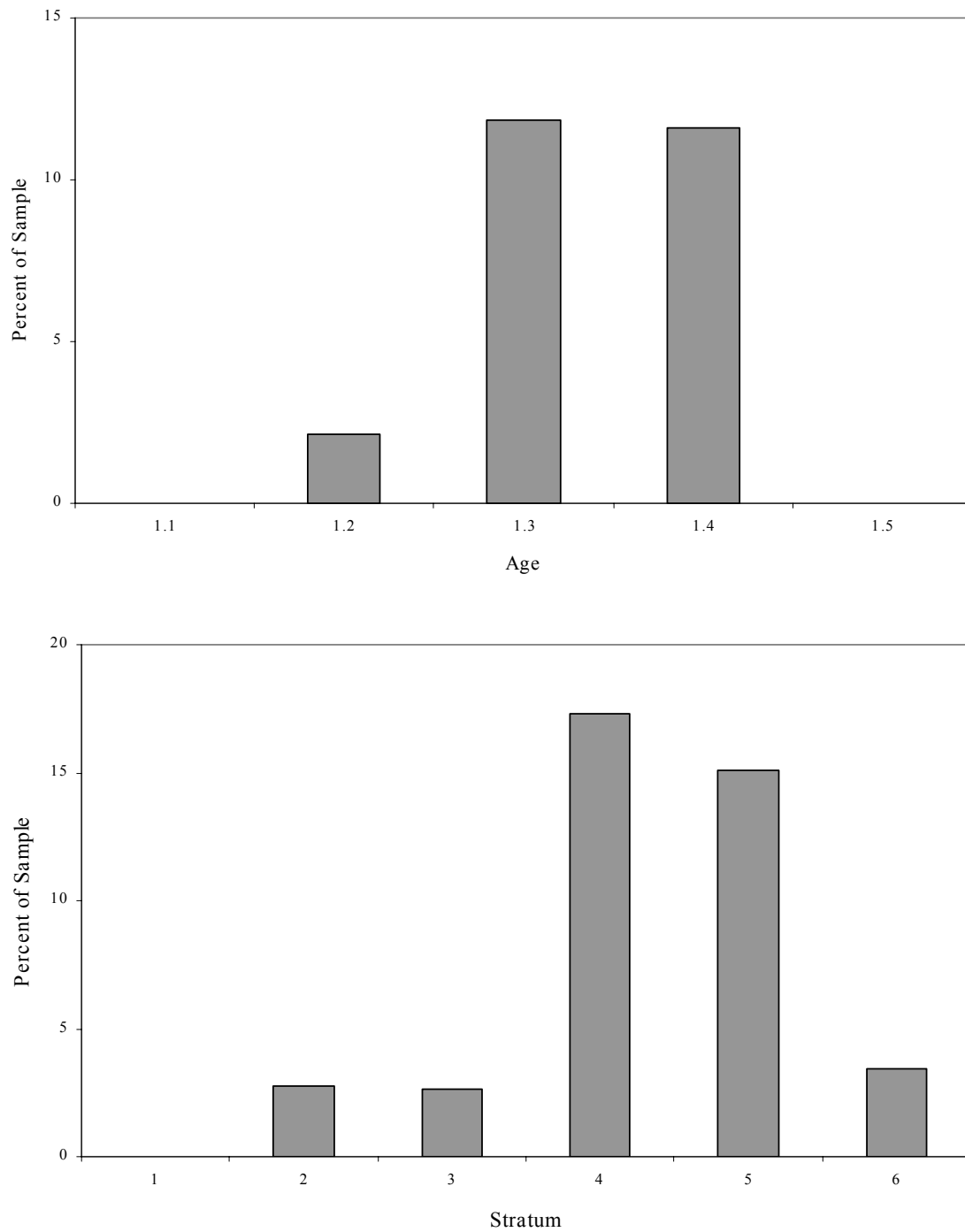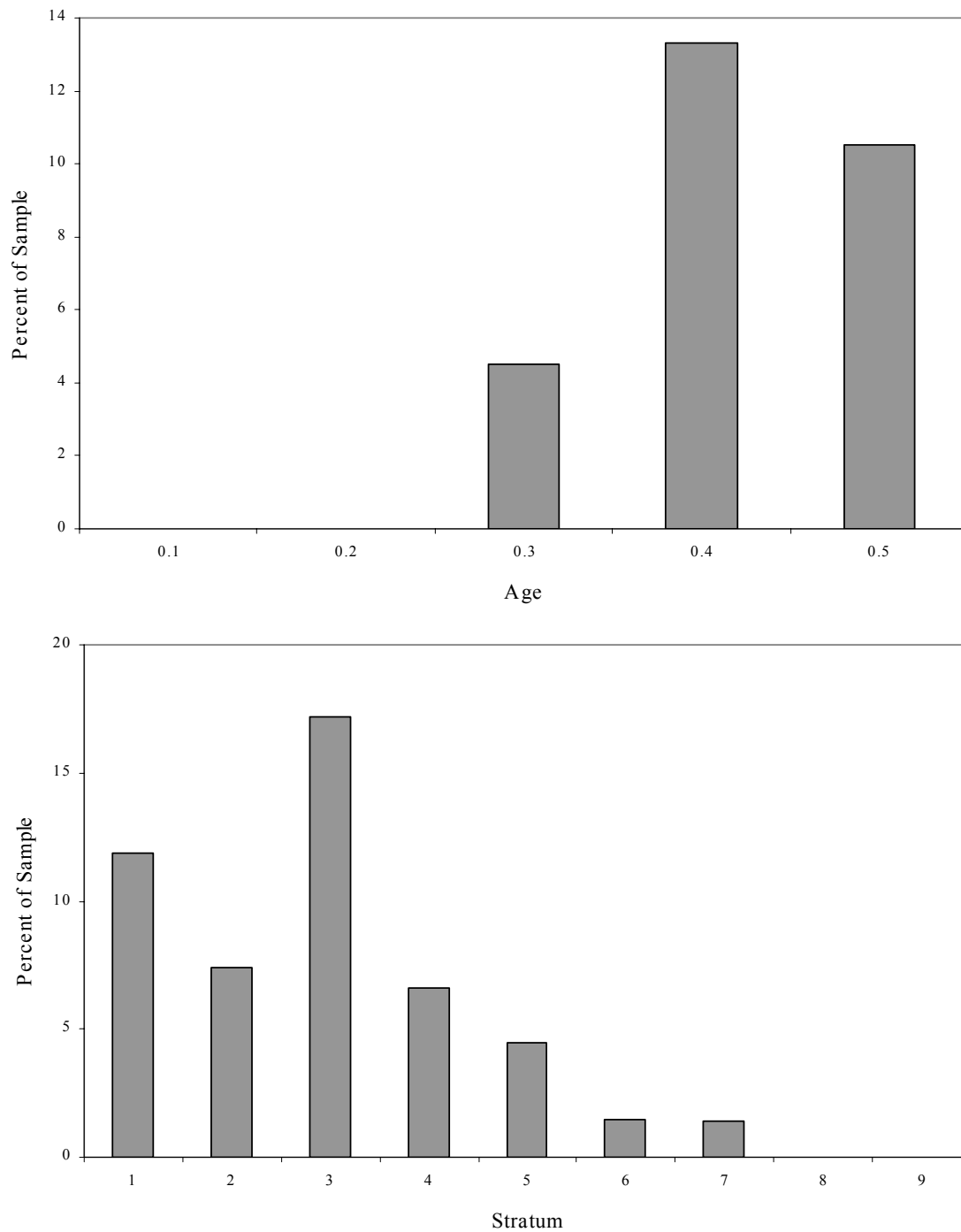
Figure 10. Percent of chum salmon with net marks by age (top) and stratum (bottom) sampled at the Big Creek weir, 2003.

Table 9. Estimated age composition and standard errors (SE) of coho salmon by stratum in Big Creek, 2003.

Stratum	n^a	Number Sampled			Proportion of Escapement					
		1.1	2.1	3.1	1.1	SE	2.1	SE	3.1	SE
1	14	4	10	0	0.29	0.12	0.71	0.12	0	--
2	51	18	32	1	0.35	0.07	0.63	0.07	0.02	0.02
3	97	12	73	11	0.12	0.03	0.75	0.04	0.11	0.03
4	100	20	71	7	0.20	0.04	0.71	0.04	0.07	0.02
5	43	6	35	2	0.14	0.05	0.81	0.05	0.05	0.03
6	106	13	80	12	0.12	0.03	0.75	0.04	0.11	0.03
7	93	4	72	16	0.04	0.02	0.77	0.04	0.17	0.04
Total:	504	77	373	49	0.16	0.02	0.74	0.02	0.09	0.01

[a] Total number sampled includes ages 1.2 ($n = 1$) and 2.2 ($n = 4$) that are not reported in table as both age classes combined made up less than one percent of the sample.

Table 10. Estimated sex composition and standard errors (SE) of coho salmon by stratum in Big Creek, 2003.

Stratum	n	Number Sampled		Proportion of Escapement		
		Female	Male	Female	Male	SE
1	14	7	7	0.50	0.50	0.14
2	51	23	28	0.45	0.55	0.07
3	97	46	51	0.47	0.53	0.05
4	100	34	66	0.34	0.66	0.05
5	43	15	28	0.35	0.65	0.07
6	106	47	59	0.44	0.56	0.05
7	93	56	37	0.60	0.40	0.05
Total:	504	228	276	0.46	0.54	0.03

Table 11. Mean, standard error (SE), range, and sample size of mid-eye-to-fork lengths (mm) by age class taken from coho salmon at the Big Creek weir, 2003.

	Age Class				
	1.1	1.2	2.1	2.2	3.1
Females					
Mean Length	589	528	619	619	622
SE	16.2	--	15.3	29.0	16.7
Range	496 - 646	--	504 - 714	599 - 640	549 - 675
Sample Size	33	1	169	2	23
Males					
Mean Length	573	--	621	629	630
SE	30.1	--	20.9	--	23.3
Range	421 - 681	--	393 - 709	618 - 650	538 - 694
Sample Size	44	0	204	2	26
All Fish					
Mean Length	580	528	620	625	626
SE	25.3	--	18.2	12.2	19.3
Range	421 - 681	--	393 - 714	599 - 650	538 - 694
Sample Size	77	1	373	4	49
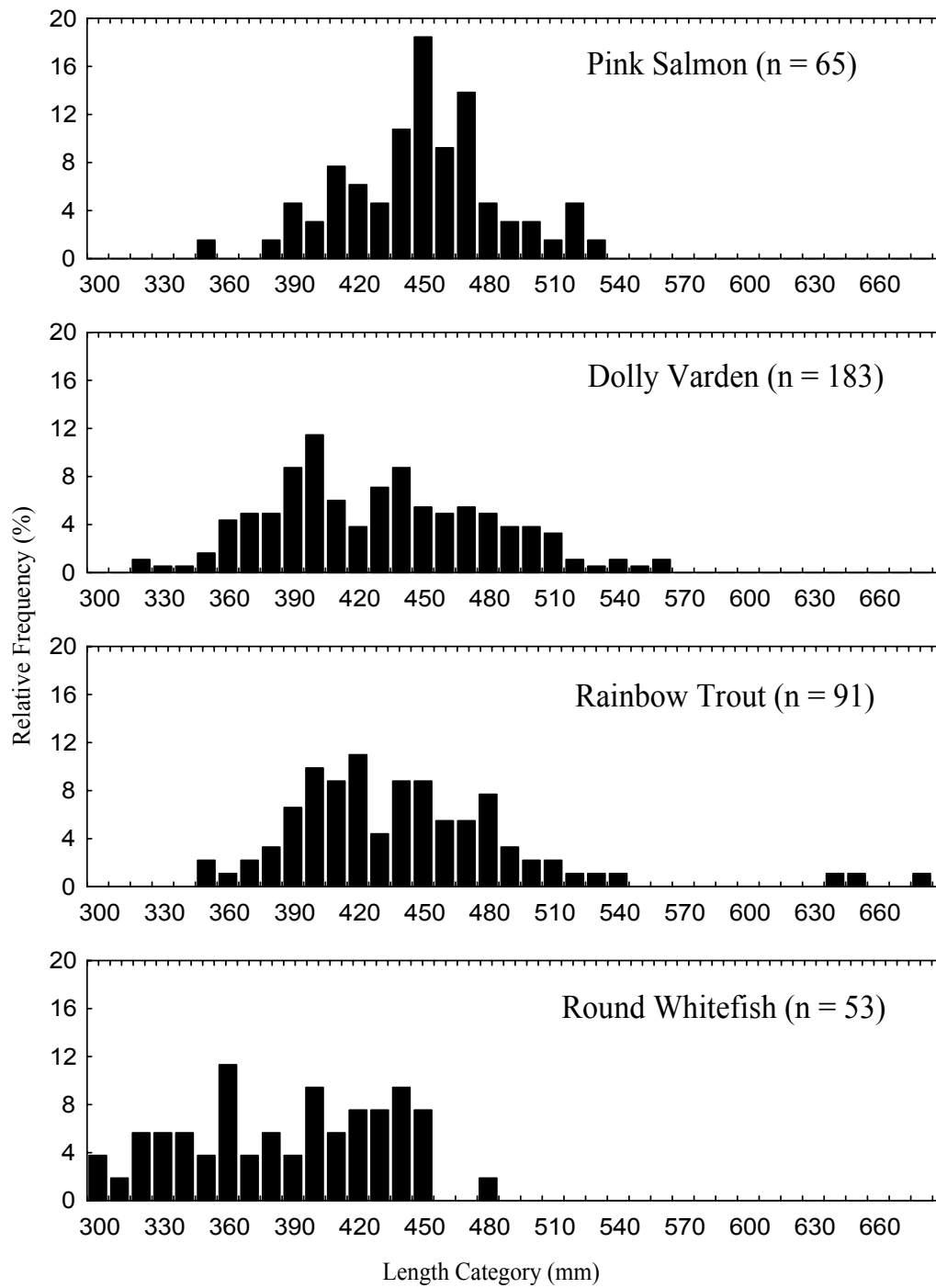
Figure 11. Length-frequency distributions of pink salmon, Dolly Varden, rainbow trout, and round whitefish sampled at the Big Creek weir, 2003.

Table 12. Numbers of fish observed at the Big Creek weir, 2000 to 2003. Data for 2000 to 2002 are from Whitton (2003).

Species	2003	2002	2001	2000
Chinook salmon	10,063	4,791	649[a]	1,298
Chum salmon	33,943	28,812	11,981[a]	3,241
Coho salmon	9,600	806[b]	4,523	969[b]
Sockeye salmon	119	45	38	57
Pink salmon	873	31	15	80
Dolly Varden	4,901	347	21[c]	24
Rainbow trout	549	24	11[c]	2
Arctic grayling	83	3	1[c]	2
Round whitefish	210	16	--	4
Northern pike	52	1	--	2
Longnose sucker	--	--	--	1

[a] Weir was not operating during peak migration period
[b] Weir was removed prior to peak migration period
[c] Numbers observed in trap box.

to picket spacing and the operation of the video monitoring equipment at the weir in 2003. In previous years, fish passing through the weir were identified to species and enumerated by an observer looking down into the water column, so water clarity and surface turbulence were factors in accurate observations. In addition, when large numbers of fish were passing through the weir, identification and enumeration focused on Pacific salmon species. Picket spacing in 2000 and 2001 also allowed smaller fish to pass through the weir undetected (Whitton 2003). In 2003, recording the images of fish passing through the video chute allowed the crew to pause the images when necessary to accurately identify and enumerate all species passing through the video chute. The use of video monitoring equipment at the weir has enabled comprehensive counts for all species, and has removed much of the variability associated with observation conditions. Video monitoring of fish passage at the Big Creek weir has also allowed fish to pass through the weir freely, eliminating much of the delay in migration timing typically associated with passage through a conventional weir.

A greater proportion of age 1.1 Chinook salmon (jacks) were sampled at the Big Creek weir than in previous years (Table 13). The sex composition in 2002 and 2003 was skewed towards males, as nearly all age 1.1 fish sampled in both years were classified as males. Sacrificing age 1.1 fish would be necessary to determine the actual sex ratio. The number of jacks sampled in 2003 may be an artifact of the trap box and video chute designs. Throughout the season it appeared that jacks were captured in the trap box at a higher proportion than those passing through the video chute, while larger Chinook salmon appeared less likely to enter the trap box. However, this hypothesis was not rigorously tested. The sample of fish captured in the trap box may overestimate the actual proportion of jacks in the run, and underestimate the proportion of larger fish (ages 1.4 and 1.5). Even though the trap box may be biased towards smaller fish, we still believe that age 1.1 Chinook salmon made up a large proportion of the escapement in 2003.

Table 13. Chinook salmon sex and age proportions (standard errors in parentheses) at the Big Creek weir, 2000 to 2003. Data for 2000 to 2002 are from Whitton (2003).

Year	% Female	Age Class (%)				
		1.1	1.2	1.3	1.4	1.5
2000	61 (2.6)	4 (1.1)	34 (2.8)	50 (3.0)	12 (1.8)	< 1
2001	50 (3.7)	2 (1.0)	7 (2.3)	33 (4.0)	56 (4.2)	< 2
2002	34 (2.5)	18 (2.3)	37 (2.9)	22 (2.4)	22 (2.4)	< 2
2003	27 (2.0)	35 (2.0)	25 (2.0)	28 (2.0)	11 (1.0)	< 1

In 2003, the age composition of chum salmon sampled at the Big Creek weir was similar to that observed in 2001, with age 0.3 fish making up over 90% of the run, and the proportion of female chum salmon in 2003 was higher than in previous years (Table 14). Age 2.1 coho salmon made up the majority of the run in 2003 as in previous years, and the proportion of females sampled was similar to 2001 and 2002 (Table 15).

Peak run timing for Chinook salmon in 2003 (early July, Figure 2) was similar to that in 2002, but earlier than the peak in 2000 and 2001 (late July, Whitton 2003). Peak run timing of chum salmon in 2003 (early August, Figure 2) was similar to 2000, but later than the peak in 2001 and 2002 (early to mid July, Whitton 2003). Peak run timing for coho salmon in 2003 (late September, Figure 2) was similar to that observed in 2001, the only other year the weir was in operation after early September (Whitton 2003).

Picket spacing of the Big Creek weir (38 mm) allows smaller fish (< 300 mm) to pass through without being enumerated, and the size at which fish can no longer pass between the pickets varies by species. Rainbow trout and Dolly Varden less than 350 mm were not captured in the trap box, although round whitefish, sockeye salmon, and Artic grayling less than this size were captured (Figure 11). Picket spacing was adequate to prevent adult Pacific salmon from passing through the weir undetected.

Table 14. Chum salmon sex and age proportions (standard errors in parentheses) at the Big Creek weir, 2000 to 2003. Data for 2000 to 2002 are from Whitton (2003).

| Year | % Female | Age Class (%) | | | | |
		0.1	0.2	0.3	0.4	0.5
2000	32 (1.7)	--	22 (1.5)	38 (2.0)	38 (1.9)	< 2
2001	27 (1.3)	--	2 (0.5)	93 (0.8)	5 (3.1)	< 1
2002	43 (1.8)	--	10 (1.0)	28 (2.0)	62 (6.5)	< 1
2003	54 (2.0)	< 1	3 (0.6)	91 (0.9)	6 (0.6)	< 2

Table 15. Coho salmon sex and age proportions (standard errors in parentheses) at the Big Creek weir, 2000 to 2003. Data for 2000 to 2002 are from Whitton (2003).

		Age Class (%)[a]		
Year	% Female	1.1	2.1	3.1
2000	30 (2.6)	9 (1.8)	87 (2.1)	3 (1.1)
2001	50 (1.9)	11 (1.3)	86 (1.4)	2 (0.6)
2002	47(3.7)	24 (3.6)	72 (3.8)	4 (1.7)
2003	46 (3.0)	16 (2.0)	74 (2.0)	9 (1.0)

[a] Table does not include ages 1.2, 2.2, or 4.1 which were less than 1% of the sample in any given year.

Recommendations

1. Investigate the apparent size bias in the trap box, and correct the bias if possible. Either modify the entrance to the trap box to allow larger fish to enter, or separately determine the length proportions for fish passing through the video chute.

2. Develop new sample size goals for ASL data collection. With the incorporation of video enumeration techniques at the weir, we have reduced or eliminated potential impacts of delayed migration timing of fish through the weir. We should continue to modify our methods to minimize impacts on migrating fish, and limiting the number of fish handled to describe the age, sex, and length compositions would further reduce these impacts.

3. Adjust sample sizes to include 15% unreadable scales, and develop goals only for age classes that comprise greater than 5% of the total run.

4. Utilize laser technology to measure fish lengths as they pass through the video chute, and estimate age compositions by developing an age-length key.

5. Make a concerted effort to increase the number of boats surveyed in 2004 to document public use on the Refuge. Also, count numbers of boats observed passing the weir that do not stop for interviews.

Acknowledgements

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Appendix A. Summary of Pacific salmon daily passage at the Big Creek weir, 2003.

Date	Chinook Count	Chinook Cum %	Chum Count	Chum Cum %	Coho Count	Coho Cum %	Pink Count	Sockeye Count
6/26/03	1	0.0	0	0.0	0	0.0	0	0
6/27/03	0	0.0	0	0.0	0	0.0	0	1
6/28/03	7	0.1	0	0.0	0	0.0	0	2
6/29/03	5	0.1	0	0.0	0	0.0	1	1
6/30/03	79	0.9	215	0.6	0	0.0	0	3
7/1/03	528	6.2	454	2.0	0	0.0	1	0
7/2/03	15	6.3	30	2.1	0	0.0	0	0
7/3/03	335	9.6	357	3.1	0	0.0	1	1
7/4/03	118	10.8	112	3.4	0	0.0	0	1
7/5/03	2	10.8	22	3.5	0	0.0	0	0
7/6/03	117	12.0	269	4.3	0	0.0	2	0
7/7/03	358	15.6	444	5.6	0	0.0	1	0
7/8/03	427	19.8	682	7.6	0	0.0	15	2
7/9/03	1,934	39.0	826	10.0	0	0.0	19	0
7/10/03	81	39.8	55	10.2	0	0.0	0	2
7/11/03	108	40.9	179	10.7	0	0.0	5	0
7/12/03	540	46.3	297	11.6	0	0.0	12	3
7/13/03	739	53.6	711	13.7	0	0.0	54	1
7/14/03	1,046	64.0	391	14.9	0	0.0	36	1
7/15/03	80	64.8	179	15.4	0	0.0	9	2
7/16/03	201	66.8	158	15.9	0	0.0	17	10
7/17/03	15	66.9	196	16.4	0	0.0	9	4
7/18/03	88	67.8	201	17.0	0	0.0	6	6
7/19/03	185	69.7	422	18.3	0	0.0	27	7
7/20/03	410	73.7	193	18.8	0	0.0	23	0
7/21/03	311	76.8	487	20.3	0	0.0	36	2
7/22/03	334	80.1	243	21.0	0	0.0	19	1
7/23/03	44	80.6	43	21.1	0	0.0	3	0
7/24/03	4	80.6	94	21.4	0	0.0	0	2
7/25/03	17	80.8	260	22.2	0	0.0	13	3
7/26/03	72	81.5	543	23.8	1	0.0	43	14
7/27/03	148	83.0	862	26.3	0	0.0	47	2
7/28/03	149	84.4	711	28.4	0	0.0	27	1
7/29/03	73	85.2	537	30.0	3	0.0	34	2
7/30/03	52	85.7	589	31.7	7	0.1	13	4
7/31/03	14	85.8	406	32.9	1	0.1	16	2
8/1/03	96	86.8	825	35.3	3	0.2	23	8
8/2/03	131	88.1	1,727	40.4	9	0.3	48	2
8/3/03	139	89.5	1,314	44.3	4	0.3	18	2
8/4/03	162	91.1	1,524	48.8	7	0.4	27	1
8/5/03	151	92.6	2,743	56.9	19	0.6	30	1
8/6/03	151	94.1	1,025	59.9	9	0.7	11	0
8/7/03	35	94.4	1,918	65.5	16	0.8	10	0
8/8/03	161	96.0	2,285	72.3	35	1.2	22	0
8/9/03	115	97.2	952	75.1	4	1.2	15	1
8/10/03	14	97.3	359	76.1	5	1.3	9	0
8/11/03	7	97.4	510	77.6	7	1.4	3	3
8/12/03	11	97.5	786	79.9	26	1.6	12	2
8/13/03	30	97.8	672	81.9	53	2.2	18	1

Appendix A. continued.

Date	Chinook Count	Chinook Cum %	Chum Count	Chum Cum %	Coho Count	Coho Cum %	Pink Count	Sockeye Count
8/14/03	33	98.1	845	84.4	72	2.9	20	1
8/15/03	56	98.7	967	87.3	108	4.1	5	0
8/16/03	15	98.8	471	88.7	36	4.4	7	0
8/17/03	14	99.0	253	89.4	35	4.8	7	0
8/18/03	2	99.0	393	90.6	7	4.9	8	0
8/19/03	5	99.0	491	92.0	54	5.4	6	0
8/20/03	7	99.1	509	93.5	80	6.3	6	0
8/21/03	1	99.1	204	94.1	101	7.3	0	0
8/22/03	11	99.2	321	95.0	112	8.5	9	0
8/23/03	11	99.3	249	95.8	92	9.4	7	2
8/24/03	19	99.5	197	96.4	101	10.5	8	4
8/25/03	11	99.6	170	96.9	28	10.8	5	1
8/26/03	4	99.7	186	97.4	75	11.6	6	2
8/27/03	10	99.8	179	97.9	41	12.0	3	1
8/28/03	10	99.9	172	98.4	56	12.6	1	0
8/29/03	3	99.9	156	98.9	294	15.6	13	1
8/30/03	4	99.9	84	99.2	296	18.7	7	1
8/31/03	2	100	48	99.3	104	19.8	3	0
9/1/03	1	100	47	99.4	173	21.6	3	1
9/2/03	2	100	52	99.6	278	24.5	4	0
9/3/03	0	100	27	99.7	110	25.6	0	0
9/4/03	0	100	29	99.7	58	26.3	0	1
9/5/03	0	100	22	99.8	163	27.9	1	0
9/6/03	0	100	6	99.8	95	28.9	3	0
9/7/03	0	100	12	99.9	50	29.5	0	0
9/8/03	1	100	10	99.9	84	30.3	0	1
9/9/03	0	100	6	99.9	178	32.2	0	0
9/10/03	0	100	5	99.9	334	35.7	2	0
9/11/03	0	100	4	99.9	325	39.1	1	0
9/12/03	1	100	5	100	447	43.7	1	0
9/13/03	0	100	2	100	365	47.5	0	0
9/14/03	0	100	4	100	149	49.1	0	0
9/15/03	0	100	1	100	5	49.1	0	0
9/16/03	0	100	0	100	6	49.2	0	0
9/17/03	0	100	3	100	70	49.9	0	0
9/18/03	0	100	1	100	7	50.0	1	0
9/19/03	0	100	0	100	3	50.0	0	0
9/20/03	0	100	0	100	1	50.0	0	0
9/21/03	0	100	0	100	1	50.0	0	1
9/22/03	0	100	1	100	0	50.0	0	0
9/23/03	0	100	1	100	34	50.4	0	0
9/24/03	0	100	0	100	13	50.5	0	0
9/25/03	0	100	1	100	229	52.9	1	1
9/26/03	0	100	0	100	2,406	78.0	0	0
9/27/03	0	100	0	100	639	84.6	0	0
9/28/03	0	100	0	100	813	93.1	0	0
9/29/03	0	100	0	100	317	96.4	0	0
9/30/03	0	100	1	100	127	97.7	0	0
10/1/03	0	100	0	100	219	100	0	0
10/2/03	0	100	0	100	0	100	0	0
Total:	**10,063**		**33,943**		**9,600**		**873**	**119**

Appendix B. Summary of Dolly Varden (DV), rainbow trout (RT), round whitefish (WF), Arctic grayling (AG), and northern pike (NP) daily passage at the Big Creek weir, 2003.

Date	DV	RT	WF	AG	NP
6/26/03	0	2	0	1	0
6/27/03	2	4	2	1	0
6/28/03	1	2	2	2	0
6/29/03	2	7	6	5	1
6/30/03	15	10	2	3	0
7/1/03	1	14	3	1	0
7/2/03	1	2	1	0	0
7/3/03	7	9	4	9	0
7/4/03	7	2	2	9	0
7/5/03	12	2	1	5	0
7/6/03	11	8	0	0	0
7/7/03	13	1	0	1	0
7/8/03	100	15	0	9	0
7/9/03	170	18	8	3	0
7/10/03	21	7	1	1	0
7/11/03	87	3	0	1	0
7/12/03	227	3	3	1	0
7/13/03	326	19	2	6	0
7/14/03	223	18	1	1	0
7/15/03	69	4	2	0	0
7/16/03	210	5	1	1	0
7/17/03	51	4	3	0	0
7/18/03	85	2	0	0	1
7/19/03	438	11	0	0	0
7/20/03	267	5	1	0	0
7/21/03	163	6	1	1	1
7/22/03	103	2	3	0	0
7/23/03	4	0	0	0	0
7/24/03	40	2	0	0	0
7/25/03	13	2	0	1	0
7/26/03	22	6	0	0	0
7/27/03	77	7	0	0	0
7/28/03	28	1	1	0	1
7/29/03	28	6	0	0	1
7/30/03	28	7	1	0	0
7/31/03	14	4	0	0	0
8/1/03	16	4	1	0	0
8/2/03	63	7	0	0	2
8/3/03	146	5	1	0	0
8/4/03	217	7	2	0	3
8/5/03	121	1	0	0	1
8/6/03	275	16	2	1	1
8/7/03	139	0	1	0	3
8/8/03	239	9	8	5	1
8/9/03	188	14	11	8	0
8/10/03	42	9	4	2	0
8/11/03	25	0	0	0	0
8/12/03	95	5	0	0	0

Appendix B. continued.

Date	DV	RT	WF	AG	NP
8/13/03	60	4	1	1	1
8/14/03	126	14	2	1	3
8/15/03	24	9	0	0	1
8/16/03	27	3	0	0	1
8/17/03	10	3	1	1	0
8/18/03	2	4	0	0	0
8/19/03	5	2	0	0	0
8/20/03	14	0	0	0	1
8/21/03	0	0	0	0	0
8/22/03	14	7	0	0	1
8/23/03	10	2	0	0	0
8/24/03	8	2	0	0	1
8/25/03	5	6	0	0	1
8/26/03	6	6	0	0	1
8/27/03	5	3	0	0	0
8/28/03	4	4	0	0	1
8/29/03	16	5	1	0	0
8/30/03	6	6	0	0	0
8/31/03	10	4	0	0	1
9/1/03	2	2	0	0	0
9/2/03	11	1	1	0	1
9/3/03	3	5	3	0	1
9/4/03	6	1	0	0	0
9/5/03	3	3	0	0	0
9/6/03	4	2	2	0	0
9/7/03	3	0	3	0	0
9/8/03	0	1	0	0	0
9/9/03	5	1	0	0	0
9/10/03	5	3	0	0	1
9/11/03	5	2	1	0	1
9/12/03	3	7	3	0	1
9/13/03	9	2	1	0	1
9/14/03	2	5	0	0	0
9/15/03	4	2	4	0	2
9/16/03	3	1	1	0	0
9/17/03	4	4	2	0	0
9/18/03	0	1	3	0	0
9/19/03	3	2	1	0	1
9/20/03	1	1	4	0	2
9/21/03	0	0	4	0	1
9/22/03	0	1	12	0	1
9/23/03	2	3	5	0	3
9/24/03	2	9	9	0	1
9/25/03	4	14	17	0	0
9/26/03	7	16	21	1	3
9/27/03	0	1	1	0	1
9/28/03	6	11	3	0	1
9/29/03	1	1	7	1	0
9/30/03	1	9	5	0	0
10/1/03	18	57	11	0	1
10/2/03	0	0	0	0	0
Total:	**4,901**	**549**	**210**	**83**	**52**